

Comparative evaluation of battery supported photovoltaic systems at the European level

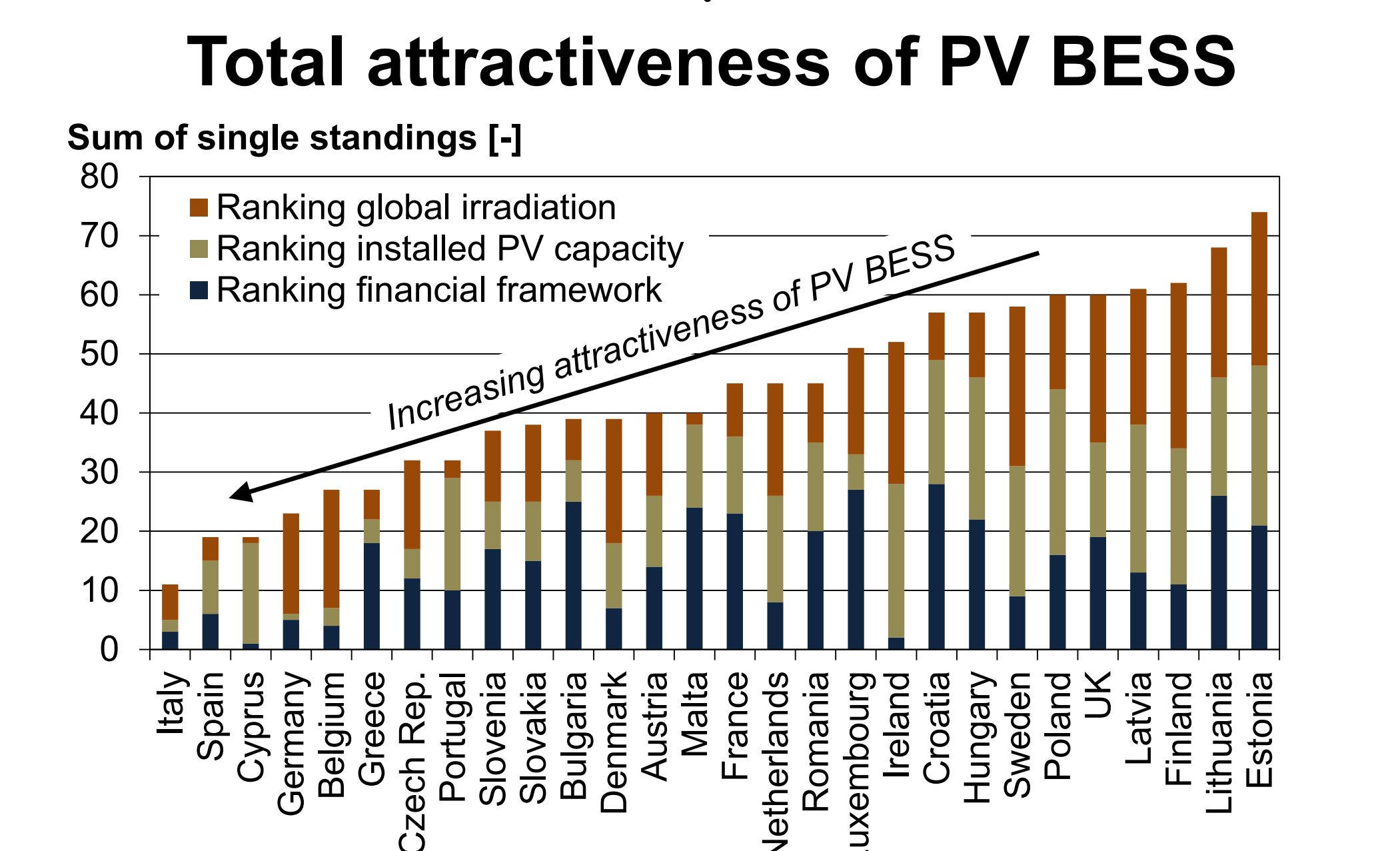
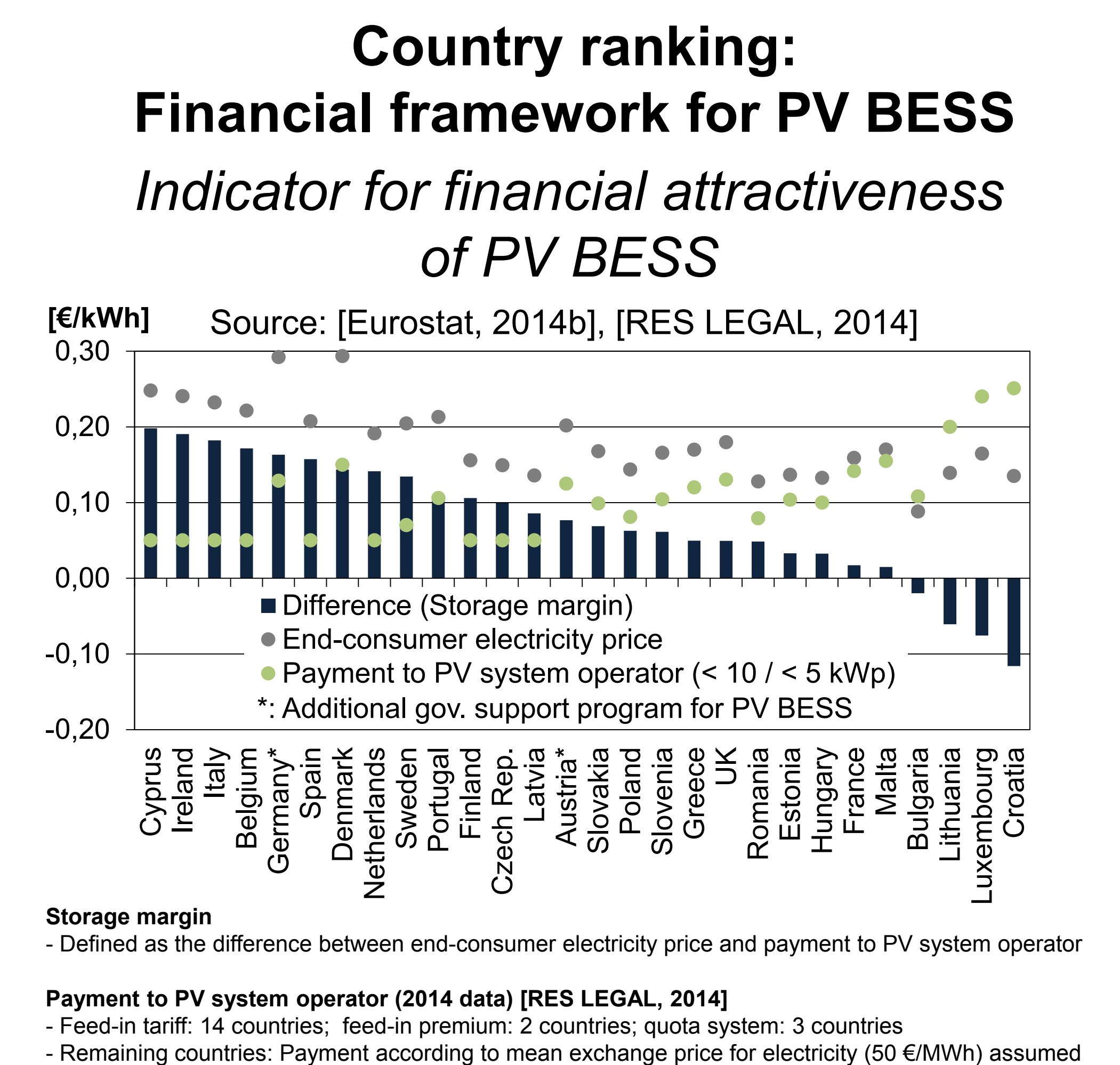
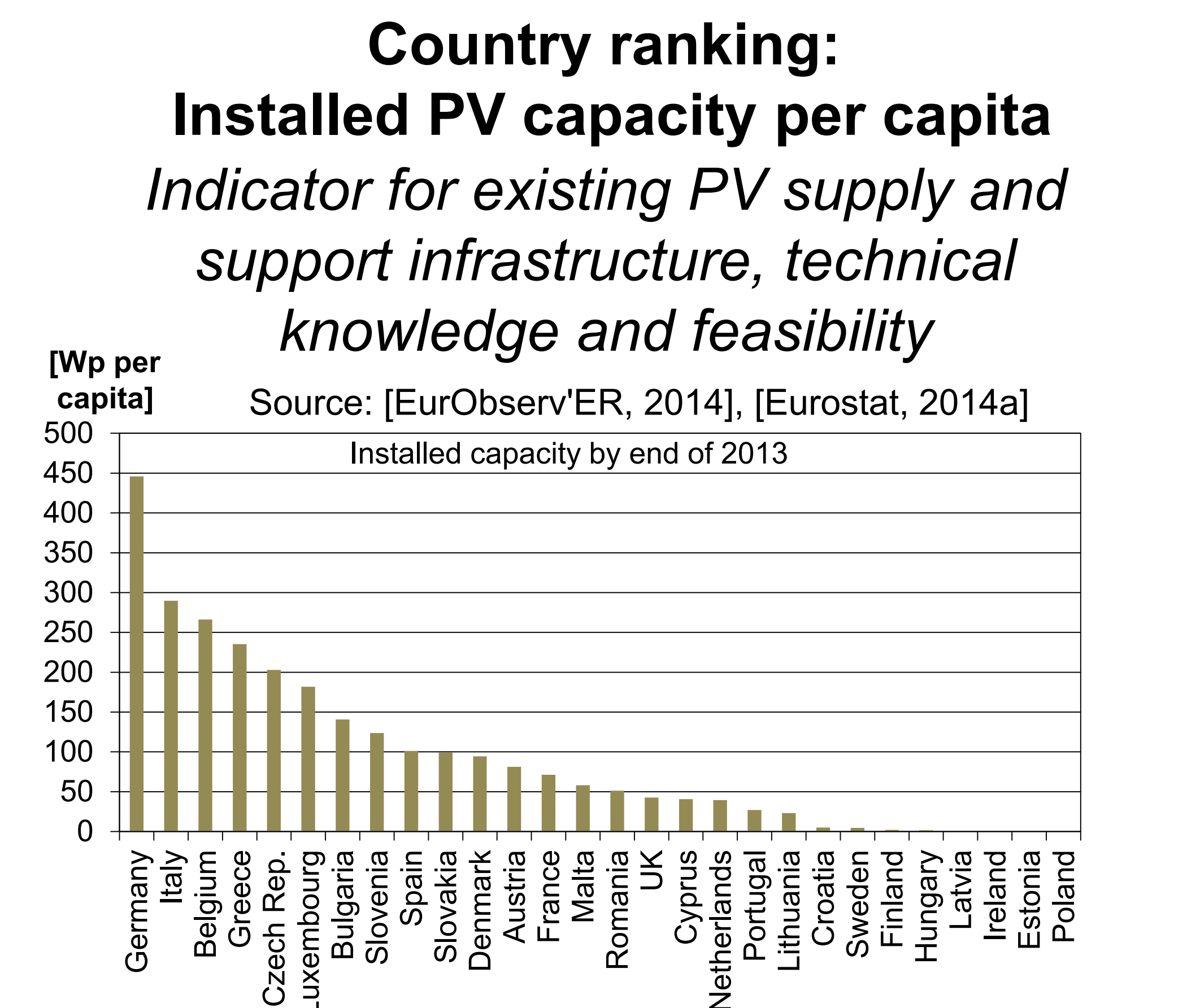
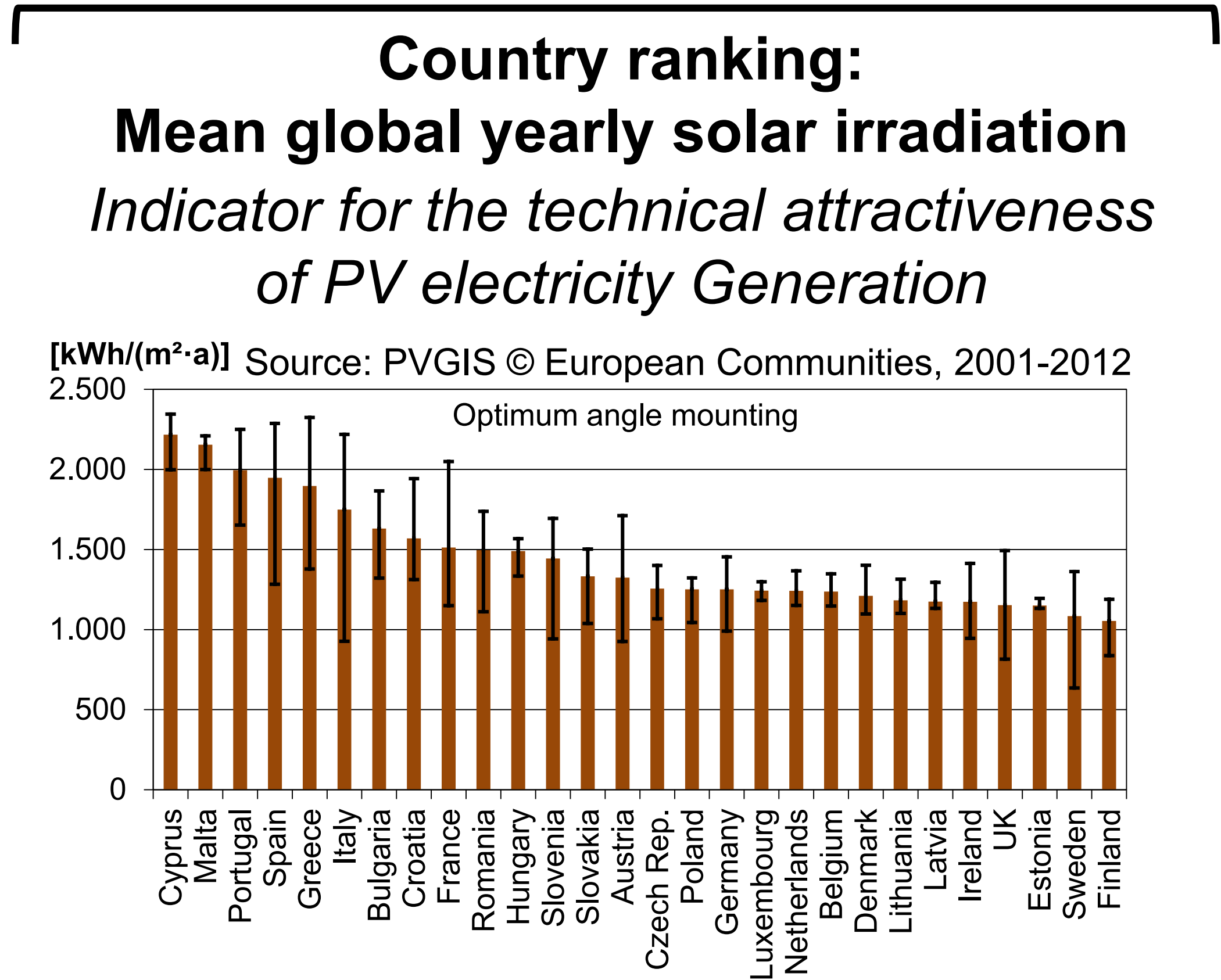
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Research topic

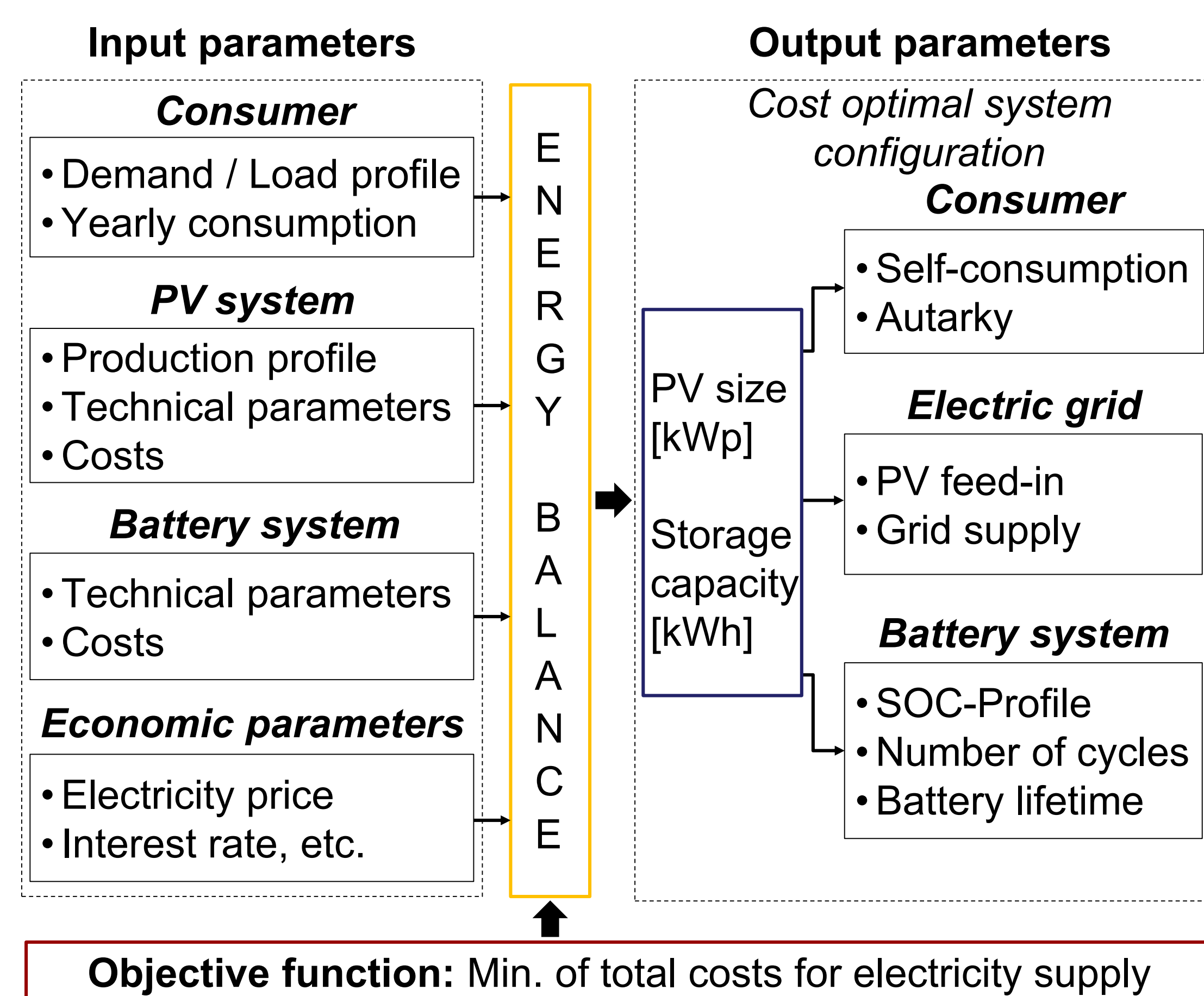
Rising end-consumer prices for electricity and decreasing photovoltaic (PV) and battery energy storage system (BESS) prices promote the attractiveness of PV BESS to increase self-consumption. The cost-effectiveness of PV BESS largely depends on the technical system design, the household demand profile, the PV production profile and the country-specific framework, which includes incentives for PV and battery systems and end-consumer electricity prices. To evaluate the attractiveness of PV BESS at the European Level (EU 28), an assessment of the country specific framework and techno-economic case studies for selected countries are presented.

Country specific framework (EU 28)



Techno-economic case studies for Italy, Spain and Germany

Structure of the BaPSi Model



General input parameters

PV system	
System price (excl. VAT)	1,640 €/kWp
Efficiency	15 %
Performance ratio (PR)	80 %
Degradation	0.5 %/a
Operation costs	1.5 %/a
Maintenance costs	10 €/(kWp·a)
Battery system (Lithium-Ion)	
System price (excl. VAT)	800 €/kWh
Efficiency	95 %
Degradation	0.4 %/a
DoD	80 %
Economic parameters	
Lifetime	20 a
Interest rate	2 %
Electricity price increase	2.5 %/a

Country specific input parameters

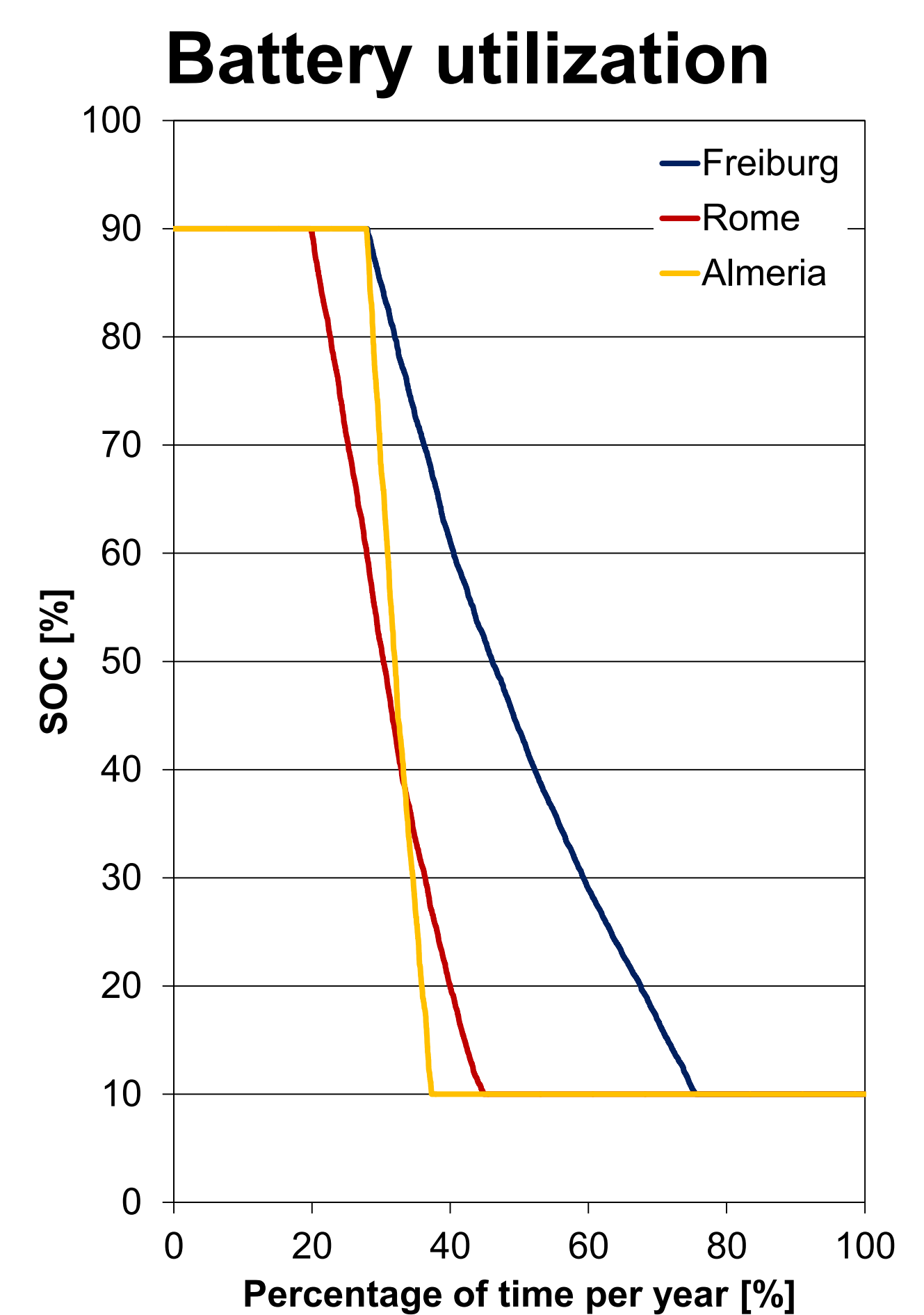
- Site-specific PV production and electricity demand profiles in 1 min. resolution
Sources: [SODA, 2014], [DWD, 2014], [Wilbert, S., 2014], [Pflugradt, N., 2014], [Izquierdo, M., et al., 2014]

Country	City	Solar yield per year [kWh/kWp]	Electricity demand [kWh/a]	VAT [%]	Electricity price [€/kWh]	Payment for grid feed-in from PV [€/kWh]	Battery support program
Italy	Rome	1,460	4,365 ¹⁾	10	0.2323	0.05 ³⁾	no
Spain	Almeria	1,670	5,200 ²⁾	21	0.2075	0.05 ³⁾	no
Germany	Freiburg	1,000	3,500	0	0.2921	0.1288 ⁴⁾	yes ⁵⁾

1) Electric AC system: COP=3; cooling demand: 3,000 kWh/a; cooling temp.: 25 °C
2) Electric AC system: COP=3; cooling demand: 5,000 kWh/a; cooling temp.: 25 °C
3) Compensation for grid feed-in according to mean exchange price (50 €/MWh) assumed
4) Feed-in tariff in Germany (EEG); reference date: July 2014 (monthly degradation)
5) Reduced credit rate and grant by KfW Program 275 Erneuerbare Energien – Speicher

Results

Performance parameters			Italy	Spain	Germany
			Rome	Almeria	Freiburg
Optimum size	PV	[kWp]	2.4	3.4	8.0
	PV+BESS	[kWp]	2.6	3.4	10.0
		[kWh]	2.1	0.8	5.0
Self-consumption	PV	[%]	48.4	52.6	21.2
	PV+BESS	[%]	62.0	56.6	30.8
Autarky	PV	[%]	38.7	55.2	48.0
	PV+BESS	[%]	51.9	59.5	83.9
Total costs (20 a)	without PV	[€]	28,244	30,070	28,476
	PV	[€]	23,756	23,059	21,876
	PV+BESS	[€]	23,316	23,046	19,441
Mean electricity price	without PV	[€/kWh]	30.8	27.5	38.8
	PV	[€/kWh]	25.9	21.1	29.8
Break-even BESS price	PV+BESS	[€/kWh]	25.4	21.1	26.5
	Grid supply	[€/kWh]	2,407	6,527	1,856
	PV	[€/kWh]	943	811	895



Conclusion

- Significant reduction of total costs for electricity supply due to PV self-consumption in Italy, Spain and Germany
 - Smaller systems with a focus on self-consumption are cost-optimal in Italy and Spain whereas Germany allows also larger systems due to PV feed-in tariff
 - Battery support program and tax relief promote the attractiveness of PV BESS especially in Germany
- ➔ Further BESS system price reduction is key to applications in other countries

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